JC11 Rec'd PCT/PTO SEP 2 1 2001

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 USC 371

ATTORNEY DOCKET NO.: 213503

U.S. APPLICATION NO.: Unassigned 09/937260

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DK00/00132	21 MARCH 2000 (21.03.00)	22 MARCH 1999 (22.03.99)

TITLE OF INVENTION
A METHOD FOR LEAKAGE CONTROL AND LOCALISATION OF LEAKAGES IN THE INTERNAL FACES OF HEAT EXCHANGERS

APPLICANT(S) FOR DO/EO/US
FAMME, Per Bruun

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.

3. ☒ This is an express request to begin national examination procedures (35 USC 371(f)).

4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).

5. ☒ A copy of the International Application as filed (35 USC 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☐ An English language translation of the International Application as filed (35 USC 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).

10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

11. Nucleotide and/or Amino Acid Sequence Submission
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper Copy
   c. ☐ Statement verifying identity of above copies

Items 12 to 19 below concern other document(s) or information included:

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
   ☒ Form PTO-1449
   ☒ Copies of Listed Documents

13. ☐ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

14. ☒ A FIRST preliminary amendment.
   ☐ A SECOND or SUBSEQUENT preliminary amendment.

15. ☐ A substitute specification.

16. ☐ A change of power of attorney and/or address letter.

17. ☒ Application Data Sheet Under 37 CFR 1.76

18. ☒ Return Receipt Postcard

19. ☒ Other items or information:
   Amendments to Specification and Claims Made Via Preliminary Amendment; Pending Claims after Entry of Preliminary Amendment; Copy of International Search Report; Filing Fee

U.S. APPLICATION NO.	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO.
Unassigned 09/937260	PCT/DK00/00132	213503

20. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,000.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... $ 860.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO, but international search fee (37 CFR 1.445(a)(2))paid to USPTO ..... $ 710.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)..... $ 690.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1) to (4) ..... $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT=	$860.00	
Surcharge of $130.00 for furnishing the National fee or oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date	$	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total Claims	16	-20=	0	x $ 18.00	$0.00	
Independent Claims	3	- 3 =	0	x $ 80.00	$0.00	
☐ Multiple Dependent Claim(s) (if applicable)				+$270.00	$	

TOTAL OF ABOVE CALCULATIONS=	$860.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.	$	
SUBTOTAL=	$860.00	
Processing fee of **$130.00** for furnishing English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date.	$	
TOTAL NATIONAL FEE=	$860.00	
Fee for recording the enclosed assignment. The assignment must be accompanied by an appropriate cover sheet. **$40.00** per property +	$	
TOTAL FEE ENCLOSED=	$860.00	
Amount to be: refunded		$
charged:		$

a. ☒ A check in the amount of $860.00 to cover the above fee is enclosed.

b. ☐ Please charge Deposit Account No. 12-1216 in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-1216. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Customer Number: 23460

23460

PATENT TRADEMARK OFFICE

Wesley O. Mueller

Wesley O. Mueller, Registration No. 33,976
One of the Attorneys for Applicant(s)

Date: September 21, 2001

JC09 Rec'd PCT/PTO 21 SEP 2001
09/937260

PATENT
Attorney Docket No. 213503

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Per Bruun Famme

Application No. Unassigned
National Phase of PCT/DK00/00132

Group No.: Unassigned

Examiner: Unassigned

Filed: September 21, 2001

For: A Method For Leakage Control And Localisation Of Leakages In The Internal Faces Of Heat Exchangers

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following preliminary amendment.

AMENDMENTS

IN THE SPECIFICATION:

Replace the paragraph beginning at page 1, lines 4-8, with:

A first aspect of the present invention relates to a method of performing in situ leakage control in the internal faces that separate the product and service sides of heat exchangers.

Replace the paragraph beginning at page 1, lines 10-13, with:

A second aspect of the invention relates to a method of localizing leakages in the internal faces that separate the product and service sides of heat exchangers.

Replace the paragraph beginning at page 1, lines 15-27, with:

The two aspects of the invention can be used separately; the first aspect for leakage control and the second aspect for localization of leakages that have been detected. However, they are usually used in combination, whereby a determination is initially carried out whether a

heat exchanger leaks, and subsequently – if any such leakage is detected – the location of the leakages is determined. It follows that, in accordance with a third aspect, the invention relates to a method comprising in situ leakage control and localization of leakages in the internal faces that separate the product and service sides of heat exchangers.

Replace the paragraph beginning at page 5, lines 1-8, with:

This technology, which is known from U.S. patent No. 4,745,797 relating to a method wherein a mineral oil based colour solution is applied to the surface of the object on which it is desired to perform the test. The colour solution that penetrates through leakages in the surfaces causes a subsequent colour reaction on the opposite side of the surface, thereby revealing the leakage.

Replace the paragraph beginning at page 5, lines 10-13, with:

An indirect colour method for localising cracks in a surface is described in DE patent No. 1,773,270, where the penetrating substance is not readily visible, but it is rendered visible by exposure to UV-light.

Replace the paragraph beginning at page 7, lines 18-34, with:

In accordance with the invention, a first step is concerned with leakage control, wherein one of the primary and secondary sides of a plate heat exchanger is supplied with a colorant liquid while the opposite side is supplied with a clear liquid that is recycled. The presence of leakages in the heat exchanger is verified by detection of the presence of colorant in the clear liquid. Hereby a reliable indication is obtained whether the heat exchanger leaks, and since it does not present any problems to find an environmentally friendly and very powerful colorant that can be measured in very small concentrations in the clear liquid, the method is both reliable and inexpensive. Moreover, it is quite simple to imitate the operating conditions during the leakage control, thereby ensuring that the control does in fact indicate the leakages that will occur in actual operation, neither more nor less.

Replace the paragraph beginning at page 8, lines 1-17, with:

In accordance with the second aspect of the invention, certain advantages are achieved when a colorant-containing liquid is supplied to one side of the heat exchanger, and when this side is pressurised for a period of time. The other side is maintained at ambient in that it contains air. After the period of time, the heat exchanger is drained and the plates are separated. Leakages are then determined by visual inspection of the plates. It is possible to find a colorant for this purpose that will, on the one hand, be readily dissolved and, on the other hand,

subsequently produce very clear indications on the opposite side of the locations of the leakages. At the same time it is very simple, by this method, to imitate the heat exchanger operating conditions. This means that the detected leakages are the same or about the same as will appear in actual operation.

Replace the paragraph beginning at page 8, lines 25-31, with:

In accordance with an optional feature of the invention, the leakage control and the localisation of leakages may be accomplished in conditions that are very close to or identical with the actual operating conditions of the heat exchanger. This involves substantial advantages since the leakages detected in this manner will be the exact same as those occurring in ordinary operation of the heat exchanger.

Replace the paragraph beginning at page 8, line 33, through page 9, line 4, with:

The colorant used can be any one of liquid or dissolvable colorant or mixtures of such substances that will, in an aqueous and highly diluted in-use solution, directly – or by means of UV-light – trigger a visualisation.

Replace the paragraph beginning at page 9, lines 6-20, with:

According to another embodiment, an aqueous solution of the fluorescent colorant uranine (the sodium salt of fluoresceine) is used. This solution has a very intense colouring and powerful fluorescence that makes it easy to visualise with UV-light in very small amounts (a dilution of uranine in a ratio of 1 to 200 mill in pure water can readily be detected by the human eye). Advantageously, this colorant is approved for use as trace substance for, among other things, life saving at sea, tracing of subterranean water current and checking of weak blood circulation in humans. Thus there will not be any problems associated with obtaining permissions to use this substance in the foodstuffs industry, and it does not present an environmental hazard.

Replace the paragraph beginning at page 9, line 22, through page 10, line 6, with:

As explained above, considerable advantages are achieved with use of the methods for leakage control and localisation of leakages in accordance with the invention. These advantages may be obtained by performing a leakage control in a first step by supplying a colorant-containing solution to one of the product and service sides of the heat exchanger. A of the heat exchanger. A clear liquid that is preferably recycled is applied to the opposite side. The presence of leakages in the heat exchanger is verified by detection of the colorant in the clear liquid. Also, the presence of leakages may be revealed by pressurisation of the side containing

the colorant-containing solution for a period of time while the other side is allowed to continue to contain air. The heat exchanger is thereafter drained and disassembled, and the localisation of the leakages is determined by visual inspection of the plates.

Replace the paragraph beginning at page 10, lines 20-25, with:

This renders the method according to the invention equally suitable for control of leakages in all types of heat exchangers in true operating conditions independently of the specific construction, field of use and operating specifications of the individual heat exchanger (pressure, temperature, viscosity of liquids, etc.).

IN THE CLAIMS:

Replace claims 1-9 with:

1. (Amended) A method for leakage control of the internal faces that separate the primary and secondary sides of a plate heat exchanger comprising the steps of:

supplying a colorant-containing liquid to one of the primary and secondary sides,

supplying a clear liquid that is recycled to the opposite side,

maintaining a differential pressure between the primary and secondary sides close to or approximately the same as the differential pressures prevailing during actual operation of the heat exchanger, and

determining whether leakages in the plate heat exchanger are present by detecting the presence of the colorant in the clear liquid.

2. (Amended) A method for localization of leakages between the primary and secondary sides of a plate heat exchanger by use of a colorant that passes through the leakage and is subsequently detected visually comprising the steps of,

supplying a colorant-containing liquid to the primary side of the plate heat exchanger,

pressurizing the primary side for a period of time,

draining the colorant-containing liquid from the plate heat exchanger, and

determining the location of leakages by visual inspection of the plates.

3. (Amended) A method according to claim 2, further comprising the step of:

maintaining a differential pressure between the primary and secondary sides close to or identical with the differential pressures prevailing during actual operation of the plate heat exchanger.

4. (Amended) A method according to claim 1 wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

5. (Amended) A method according to claim 1 wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

6. (Amended) A method according to claim 1 wherein the colorant is a fluorescent substance.

7. (Amended) A method according to claim 1 wherein the detection of the colorant is effected by use of UV-light.

8. (Amended) A method according to claim 1 wherein the colorant is a salt of fluoresceine.

9. (Amended) A method for in situ leakage control and localisation of leakages in the internal faces that separate the primary and secondary sides of a plate heat exchanger comprising the steps of:

supplying a colorant-containing liquid to one of the primary and second sides of the plate heat exchanger;

supplying a recycled clear liquid to the opposite side of the plate heat exchanger;

maintaining the differential pressure between the primary and secondary sides of the plate heat exchanger close to or identical with the differential pressures prevailing during actual operation of the heat exchanger;

detecting the presence of leakages in the plate heat exchanger by detection of the presence of the colorant in the clear liquid;

maintaining the colorant-containing liquid at a predetermined pressure for a period of time, while the clear liquid id drained from the opposite side; and

draining and disassembling the plate heat exchanger to determine the location of the leakages by visual inspection of the plates.

Please add the following claims:

10. (New) A method as in claim 8 wherein the slat of fluorescence is a sodium salt uranine thereof.

11. (New) A method according to claim 2 wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

12. (New) A method according to claim 2 wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

13. (New) A method according to claim 2 wherein the colorant is a fluorescent substance.

14. (New) A method according to claim 2 wherein the detection of the colorant is effected by use of UV-light.

15. (New) A method according to claim 2 wherein the colorant is a salt of fluoresceine, the sodium salt uranine thereof.

16. (New) A method as in claim 8 wherein the salt of fluorescence is a sodium salt uranine thereof.

Respectfully submitted,

Wesley O. Mueller, Reg. No. 33,976
One of the Attorneys for Applicant(s)
LEYDIG, VOIT & MAYER, LTD.
Two Prudential Plaza, Suite 4900
180 North Stetson
Chicago, Illinois 60601-6780
(312) 616-5600 (telephone)
(312) 616-5700 (facsimile)

Date: September 21, 2001

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09/937260

PATENT
Attorney Docket No. 213503

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Per Bruun Famme

Application No. Unassigned
National Phase of PCT/DK00/00132

Group No.: Unassigned

Examiner: Unassigned

Filed: September 21, 2001

For: A Method For Leakage Control And Localisation Of Leakages In The Internal Faces Of Heat Exchangers

PCT/DK00/00132 09937260 21-09-01

AMENDMENTS TO SPECIFICATION AND CLAIMS MADE VIA PRELIMINARY AMENDMENT

Amend the paragraph beginning at page 1, lines 4-8, as follows:

A first aspect of the present invention relates to a method of performing in situ leakage control in the internal faces that separate the product and service sides of heat exchangers[, as featured in the preamble of claim 1].

Amend the paragraph beginning at page 1, lines 10-13, as follows:

[Besides, a] A second aspect of the invention relates to a method of localizing leakages in the internal faces that separate the product and service sides of heat exchangers[, as featured in the preamble of claim 2].

Amend the paragraph beginning at page 1, lines 15-27, as follows:

The two aspects of the invention can be used separately; the first aspect for leakage control and the second aspect for localization of leakages that have been detected. However, they are usually used in combination, whereby a determination is initially carried out whether a heat exchanger leaks, and subsequently – if any such leakage is detected – the location of the leakages is determined. It follows that, in accordance with a third aspect, the invention relates to a method comprising in situ leakage control and localization of leakages in the internal faces that separate the product and service sides of heat exchangers[, as featured in the preamble of claim 9].

Amend the paragraph beginning at page 5, lines 1-8, as follows:

This technology, which is known from [ia] U.S. patent No. 4,745,797 relating to a method wherein a mineral oil based colour solution is applied to the surface of the object on which it is desired to perform the test. The colour solution that penetrates through leakages in the surfaces causes a subsequent colour reaction on the opposite side of the surface, thereby revealing the leakage.

Amend the paragraph beginning at page 5, lines 10-13, as follows:

An indirect colour method for localising cracks in a surface is described [ia] in DE patent No. 1,773,270, where the penetrating substance is not readily visible, but it is rendered visible by exposure to UV-light.

Amend the paragraph beginning at page 7, lines 18-34, as follows:

[The method according to the preamble of claim 1 is thus characterised in that] In accordance with the invention, a first step is concerned with leakage control, wherein one of the primary and secondary sides of a plate heat exchanger is supplied with a colorant liquid while the opposite side is supplied with a clear liquid that is recycled[, whereby the]. The presence of leakages in the heat exchanger is verified by detection of the presence of colorant in the clear liquid. Hereby a reliable indication is obtained whether the heat exchanger leaks, and since it does not present any problems to find an environmentally friendly and very powerful colorant that can be measured in very small concentrations in the clear liquid, the method is both reliable and inexpensive. Moreover, it is quite simple to imitate the operating conditions during the leakage control, thereby ensuring that the control does in fact indicate the leakages that will occur in actual operation, neither more nor less.

Amend the paragraph beginning at page 8, lines 1-17, as follows:

In accordance with the second aspect of the invention [as featured in the preamble of claim 2], [the] certain advantages are [obtained in that] achieved when a colorant-containing liquid is supplied to [the] one side of the heat exchanger, and [that] when this side is pressurised for a period of time[,]. [whereas the] The other side is [allowed to continue to contain] maintained at ambient in that it contains air[,]. [following which] After the period of time, the heat exchanger is drained and the plates are separated. [and the leakages] Leakages are then determined by visual inspection of the plates. It is possible to find a colorant for this purpose that will, on the one hand, be readily dissolved and, on the other hand, subsequently produce very clear indications on the opposite side of the locations of the leakages. At the same time it is very simple, by this method, to imitate the heat exchanger operating conditions. [, which] This

means that the detected leakages are the same or about the same as will appear in actual operation.

Amend the paragraph beginning at page 8, lines 25-31, as follows:

[As stipulated in claims 3 through 5] In accordance with an optional feature of the invention, the leakage control and the localisation of leakages [are] may be accomplished in conditions that are very close to or identical with the actual operating conditions of the heat exchanger. This involves substantial advantages since the leakages detected in this manner will be the exact same as those occurring in ordinary operation of the heat exchanger.

Amend the paragraph beginning at page 8, line 33, through page 9, line 4, as follows:

The colorant used [in the method according to claim 1 or 2,] can be any one of liquid or dissolvable colorant or mixtures of such substances that will, in an aqueous and highly diluted in-use solution, directly – or [as featured in claim 7] by means of UV-light – trigger a visualisation.

Amend the paragraph beginning at page 9, lines 6-20, as follows:

According to [an] another embodiment [as featured in claim 8], an aqueous solution of the fluorescent colorant uranine (the sodium salt of fluoresceine) is used [that distinguishes itself in having] . This solution has a very intense colouring and powerful fluorescence that makes it easy to visualise with UV-light in very small amounts (a dilution of uranine in a ratio of 1 to 200 mill in pure water can readily be detected by the human eye)[, and in being]. Advantageously, this colorant is approved for use as trace substance for, among other things, life saving at sea, tracing of subterranean water current and checking of weak blood circulation in humans. Thus there will not be any problems associated with obtaining permissions to use this substance in the foodstuffs industry, and it does not present an environmental hazard.

Amend the paragraph beginning at page 9, line 22, through page 10, line 6, as follows:

As [stipulated previously, it will be associated with] explained above, considerable advantages [to] are achieved with use of the methods for leakage control and localisation of leakages[, respectively,] in accordance with [a combination of claims 1 and 2; and these] the invention. These advantages [are] may be obtained by [– as stipulated in claim 9 –] performing a leakage control [being performed] in a first step [in which] by supplying a colorant-containing solution [is supplied] to one of the product and service sides[, whereas a] of the heat exchanger. A of the heat exchanger. A clear liquid that is preferably recycled is applied to the opposite side[, whereby the] . The presence of leakages in the heat exchanger is verified by detection of

the colorant in the clear liquid[; and in a second step being performed in which]. Also, the presence of leakages [is] may be revealed by pressurisation of the side containing the colorant-containing solution for a period of time while the other side is allowed to continue to contain air[, following which the]. The heat exchanger is thereafter drained and disassembled, and the localisation of the leakages is determined by visual inspection of the plates.

Amend the paragraph beginning at page 10, lines 20-25, as follows:

This renders the method according to [claim 9] the invention equally suitable for control of leakages in all types of heat exchangers in true operating conditions independently of the specific construction, field of use and operating specifications of the individual heat exchanger (pressure, temperature, viscosity of liquids, etc.).

Please amend Claims 1-9 as follows:

1. (Amended) A method for leakage control of the internal faces that separate the primary and secondary sides of a plate heat exchanger [, characterised in that] comprising the steps of:

supplying a colorant-containing liquid [is supplied] to one of the primary and secondary sides,

[while] supplying a clear liquid that is recycled [is supplied] to the opposite side,

[in which method for leakage control the] maintaining a differential pressure between the primary and secondary sides [is] close to or [identical with] approximately the same as the differential pressures prevailing during actual operation of the heat exchanger, [whereby the presence of] and

determining whether leakages in the plate heat exchanger [is verified] are present by [detection of] detecting the presence of the colorant in the clear liquid.

2. (Amended) A method for localization of leakages between the primary and secondary sides of a plate heat exchanger by use of a colorant that passes through the leakage and is subsequently detected visually comprising the steps of, [characterised in that]

supplying a colorant-containing liquid [is supplied] to the [one] primary side of the plate heat exchanger,

[and that this] pressurizing the primary side [is pressurized] for a period of time, [while the opposite side contains air,]

[following which] draining the colorant-containing liquid from the plate heat exchanger, [is drained and disassembled,] and

determining the location of [the] leakages [is determined] by visual inspection of the plates.

3. (Amended) A method according to claim 2, [characterised in that] further comprising the step of:

[the] maintaining a differential pressure between the primary and secondary sides [is] close to or identical with the differential pressures prevailing during actual operation of the plate heat exchanger.

4. (Amended) A method according to claim 1 [or 2, characterised in that] wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

5. (Amended) A method according to claim 1 [or 2, characterised in that] wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

6. (Amended) A method according to claim 1 [or 2, characterised in that] wherein the colorant is a fluorescent substance.

7. (Amended) A method according to claim 1 [or 2, characterised in that] wherein the detection of the colorant is effected by use of UV-light.

8. (Amended) A method according to claim 1 [or 2, characterised in that] wherein the colorant is a salt of fluoresceine [, preferably the sodium salt uranine thereof].

9. (Amended) A method for in situ leakage control and localisation of leakages in the internal faces that separate the primary and secondary sides of a plate heat exchanger[,] comprising the steps of:

[characterised in that a leakage control is performed in a first step wherein] supplying a colorant-containing liquid [is supplied] to one of the primary and second sides[,] of the plate heat exchanger;

[while a] supplying a recycled clear liquid [that is recycled is supplied] to the opposite [,] side of the plate heat exchanger;

[in which method for leakage control] maintaining the differential pressure between the primary and secondary sides [is] of the plate heat exchanger close to or identical with the differential pressures prevailing during actual operation of the heat exchanger[,] ;

[whereby] detecting the presence of leakages in the plate heat exchanger [is verified] by detection of the presence of the colorant in the clear liquid;

[and that, in a second step, the presence of leakages entails that the] maintaining the colorant-containing liquid [on one side remains pressurised] at a predetermined pressure for a period of time, while the clear liquid id drained from the opposite side [is drained to contain air,] ; and

[following which] draining and disassembling the plate heat exchanger [is drained and disassembled, and] to determine the location of the leakages [is determined] by visual inspection of the plates.

Please add the following claims 10-16:

10. (New) A method as in claim 8 wherein the slat of fluorescence is a sodium salt uranine thereof.

11. (New) A method according to claim 2 wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

12. (New) A method according to claim 2 wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

13. (New) A method according to claim 2 wherein the colorant is a fluorescent substance.

14. (New) A method according to claim 2 wherein the detection of the colorant is effected by use of UV-light.

15. (New) A method according to claim 2 wherein the colorant is a salt of fluoresceine, the sodium salt uranine thereof.

16. (New) A method as in claim 8 wherein the salt of fluorescence is a sodium salt uranine thereof.

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In re Application of:

Per Bruun Famme

Group No.: Unassigned

Application No. Unassigned
National Phase of PCT/DK00/00132

Examiner: Unassigned

Filed: September 21, 2001

For: A Method For Leakage Control And Localisation Of Leakages In The Internal Faces Of Heat Exchangers

PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1. A method for leakage control of the internal faces that separate the primary and secondary sides of a plate heat exchanger comprising the steps of:

supplying a colorant-containing liquid to one of the primary and secondary sides,

supplying a clear liquid that is recycled to the opposite side,

maintaining a differential pressure between the primary and secondary sides close to or approximately the same as the differential pressures prevailing during actual operation of the heat exchanger, and

determining whether leakages in the plate heat exchanger are present by detecting the presence of the colorant in the clear liquid.

2. A method for localization of leakages between the primary and secondary sides of a plate heat exchanger by use of a colorant that passes through the leakage and is subsequently detected visually comprising the steps of,

supplying a colorant-containing liquid to the primary side of the plate heat exchanger,

pressurizing the primary side for a period of time,

draining the colorant-containing liquid from the plate heat exchanger, and

determining the location of leakages by visual inspection of the plates.

3. A method according to claim 2, further comprising the step of:

maintaining a differential pressure between the primary and secondary sides close to or identical with the differential pressures prevailing during actual operation of the plate heat exchanger.

4. A method according to claim 1 wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

5. A method according to claim 1 wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

6. A method according to claim 1 wherein the colorant is a fluorescent substance.

7. A method according to claim 1 wherein the detection of the colorant is effected by use of UV-light.

8. A method according to claim 1 wherein the colorant is a salt of fluoresceine.

9. A method for in situ leakage control and localisation of leakages in the internal faces that separate the primary and secondary sides of a plate heat exchanger comprising the steps of:

supplying a colorant-containing liquid to one of the primary and second sides of the plate heat exchanger;

supplying a recycled clear liquid to the opposite side of the plate heat exchanger;

maintaining the differential pressure between the primary and secondary sides of the plate heat exchanger close to or identical with the differential pressures prevailing during actual operation of the heat exchanger;

detecting the presence of leakages in the plate heat exchanger by detection of the presence of the colorant in the clear liquid;

maintaining the colorant-containing liquid at a predetermined pressure for a period of time, while the clear liquid id drained from the opposite side; and

draining and disassembling the plate heat exchanger to determine the location of the leakages by visual inspection of the plates.

10. A method as in claim 8 wherein the slat of fluorescence is a sodium salt uranine thereof.

11. A method according to claim 2 wherein the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes through the corresponding side of the plate heat exchanger in actual operation.

12. A method according to claim 2 wherein the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the plate heat exchanger in actual operation.

13. A method according to claim 2 wherein the colorant is a fluorescent substance.

14. A method according to claim 2 wherein the detection of the colorant is effected by use of UV-light.

15. A method according to claim 2 wherein the colorant is a salt of fluoresceine, the sodium salt uranine thereof.

16. A method as in claim 8 wherein the salt of fluorescence is a sodium salt uranine thereof.

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A method for leakage control and localisation of leakages in the internal faces of heat exchangers

A first aspect of the present invention relates to a method of performing in situ leakage control in the internal faces that separate the product and service sides of heat exchangers, as featured in the preamble of claim 1.

Besides, a second aspect of the invention relates to a method of localizing leakages in the internal faces that separate the product and service sides of heat exchangers, as featured in the preamble of claim 2.

The two aspects of the invention can be used separately; the first aspect for leakage control and the second aspect for localization of leakages that have been detected. However, they are usually used in combination, whereby a determination is initially carried out whether a heat exchanger leaks, and subsequently - if any such leakage is detected - the location of the leakages is determined. It follows that, in a accordance with a third aspect, the invention relates to a method comprising in situ leakage control and localization of leakages in the internal faces that separate the product and service sides of heat exchangers, as featured in the preamble of claim 9.

In the use of heat exchangers for heating and/or cooling liquids - including ia foodstuffs - it is of the utmost importance to the optimal functioning of the heat exchanger that the liquids on the product and service sides are separated completely. It is also of the utmost importance that impurities are not transferred from the

product side to the service side, and vice versa, whereby cross-contamination may occur of the liquids that are subject to thermal treatment via the heat exchanger.

Contact between the liquids on the product and service sides is primarily a result of leakages - holes, cracks and the like in the surfaces between the product and service sides of the heat exchanger. Such leakages can occur during the manufacture proper of the heat exchanger, during mounting/assembly of the heat exchanger and during operation of the heat exchanger as a consequence of material stress and corrosion.

In the practice of the art to this date relating to checking for leakages in the faces between the product and service sides of heat exchangers, the leakage control was carried out by pressure drop measurement, conductivity measurement and ultrasound detection on the assembled, operative heat exchanger. In the detection of leakages a penetration test is subsequently carried out of the internal faces of the disassembled heat exchanger to accurately localise leakages. This practice is known ia from the disclosures of the company Bactoforce in their Qualitätsmanagement-Handbuch, section "Prüfung von Plattenwärmeaustauschern"

Leakage control by pressure drop measurement is carried out by application of pressure to the one side of the heat exchanger surface, following which detection of pressure drop will indicate that a leakage is present in the faces between the product and service sides.

This technology suffers from the overall weakness that it presupposes that the heat exchanger is without external

leaks and that, in order for a measurable pressure drop to be detected within a reasonable measurement period, the leakage between the product and service sides must be considerable.

Measurement of conductivity for leakage control is based on the principle that if an electrolyte is supplied to the one side of a water-filled heat exchanger, a transmission of this electrolyte via leakages in the surfaces will entail an increase in the conductivity of the liquid on the other side of the heat exchanger. Leakage determination of this kind is usually performed with operative pressure on the electrolyte side and an amount of water circulating over a conductivity measurement device on the opposite side.

It is a substantial drawback of this method for leakage control that it presupposes a considerable transfer of electrolytes before significant measurement of conductivity can be achieved. For example, it presupposes a transferred amount of a 3.25 W/V% of NaCl-solution of 90 ml per 100 l of circulating water in which the conductivity is measured to obtain a change in conductivity of a scale of 10 μS, which is the value used by Bactoforce as its lower limit for detecting leakages.

The ultrasound method that has been developed for detecting leakages in plate heat exchangers and that is described in EP 734,511 comprises the steps of pressurised air on the one side of the stack of plates which is transmitted via leakages in the surface to the other and water-filled side of the stack of plates thus generates a sound that can be measured on the outside with an ultrasound transducer.

This technology is associated with the overall problem that leakages in the heat exchanger cannot be localised to a specific heat exchanger element, but exclusively to a more or less comprehensive segment of heat exchanger elements; and that the sound picture from a hole, in which much sound is generated, can interfere and mask the sound picture from another hole, in which less sound is generated, whereby the latter becomes undetectable; and that the leakage must be so comprehensive that a measurable sound is generated by the passage of air via the leakage. Finally, this technology does not lend itself for use with every type of heat exchangers; it is useful for plate heat exchangers only.

This means that detection of the presence, location and magnitude of leakages in the individual heat exchanger element presupposes a subsequent penetration test of all the elements contained in the segment of elements in which a sound picture has been measured, which means that the final detection of leakages is subject to the criteria, errors and deficiencies associated with such method.

Penetration testing of the internal faces between the product and service sides of the disassembled heat exchanger is typically carried out by a liquid substance being applied to either the product side or the service side, said substance being able to penetrate through leakages in the surface whereby the leakages are visualised when the presence of the penetrating substance is detected on the opposite side of the treated surface.

This technology, which is known from ia US patent No 4,745,797 relating to a method wherein a mineral oil based colour solution is applied to the surface of the object on which it is desired to perform the test. The colour solution that penetrates through leakages in the surfaces causes a subsequent colour reaction on the opposite side of the surface, thereby revealing the leakage.

An indirect colour method for localising cracks in a surface is described ia in DE patent No 1,773,270, where the penetrating substance is not readily visible, but it is rendered visible by exposure to UV-light.

It is a general property of all penetration methods as described in the above-mentioned references that - used on the internal faces between product and service sides in heat exchangers - they presuppose disassembly of the heat exchanger and direct application of the penetrating substance on either the product or the service side of each individual heat exchanger element. Moreover, the only substances known today that possess the requisite penetrating properties are based on mineral oil, which causes serious problems, especially within the food industry.

This technology for detecting leakages in the internal faces between the product and service sides of heat exchangers is very time consuming and cumbersome from a financial point of view, and the technology does not lend itself for in situ leakage control while simultaneously determining the location of leakages, on the one hand because the method presupposes initial dismounting of the heat exchanger, and on the other hand because heat

exchangers cannot, due to environmental and safety considerations in general, be filled with a mineral oil based penetrating substance in situ. Moreover, it is deficient with regard to detecting all the leakages that might be present in the surface while the heat exchanger is in operation, partly because the penetration is accomplished with the same pressure throughout the entire heat exchanger surface, and partly because the same pressure prevails on the product and the service sides. In operating conditions, the heat exchanger surfaces are exposed to elevated and very different pressures as well as pressure differences between the product and service sides.

The technology known and used today for leakage control and localisation of leakages in the internal faces between the product and service sides in heat exchangers with a view to control and replacement of leaking elements does not - irrespectively of the chosen technique or combination of known techniques - lend itself for use for in situ leakage control with simultaneous localisation of leakages. Moreover, the technologies are associated with very substantial drawbacks and costs, which entails that they are not suitable as such.

The most considerable drawbacks consist in the technology being deficient or unsuitable with regard to obtaining a reliable and, while the heat exchanger is in operation, complete leakage control; and that localisation of leakages cannot be performed in situ and can only be performed on the disassembled heat exchanger; and that the technology is very expensive and time-consuming.

Thus, novel technologies are very much in demand, by which it is possible to perform in situ leakage control while accurately simulating actual operative conditions; to swiftly, uniformly and in a completely reproducible manner ensure that heat exchangers function optimally by the internal surfaces between product and service sides internally of the heat exchanger being completely without leakages and without any risk of transmitting and cross-contaminating the liquid substances - including foodstuffs - that are subjected to thermal treatment in the heat exchanger.

With the method according to the first aspect of the invention a surprisingly simple, swift, inexpensive and reliable technology is provided whereby this result can be achieved.

The method according to the preamble of claim 1 is thus characterised in that a first step is concerned with leakage control, wherein one of the primary and secondary sides is supplied with a colorant liquid while the opposite side is supplied with a clear liquid that is recycled, whereby the presence of leakages in the heat exchanger is verified by detection of the presence of colorant in the clear liquid. Hereby a reliable indication is obtained whether the heat exchanger leaks, and since it does not present any problems to find an environmentally friendly and very powerful colorant that can be measured in very small concentrations in the clear liquid, the method is both reliable and inexpensive. Moreover, it is quite simple to imitate the operating conditions during the leakage control, thereby ensuring that the control does in fact indicate the leakages that will occur in actual operation, neither more nor less.

In accordance with the second aspect of the invention as featured in the preamble of claim 2, the advantages are obtained in that a colorant-containing liquid is supplied to the one side of the heat exchanger, and that this side is pressurised for a period of time, whereas the other side is allowed to continue to contain air, following which the heat exchanger is drained and separated and the leakages are determined by visual inspection of the plates. It is possible to find a colorant for this purpose that will, on the one hand, be readily dissolved and, on the other hand, subsequently produce very clear indications on the opposite side of the locations of the leakages. At the same time it is very simple, by this method, to imitate the operating conditions, which means that the detected leakages are the same as will appear in actual operation.

Hereby it is possible to visually detect all leakages throughout the entire internal face of the heat exchanger, and to do so on each of the internal surface elements that separate the product and service sides of the heat exchanger.

As stipulated in claims 3 through 5 the leakage control and the localisation of leakages are accomplished in conditions that are very close to or identical with the actual operating conditions of the heat exchanger. This involves substantial advantages since the leakages detected in this manner will be the exact same as those occurring in ordinary operation of the heat exchanger.

The colorant used in the method according to claim 1 or 2, can be any one of liquid or dissolvable colorant or

mixtures of such substances that will, in an aqueous and highly diluted in-use solution, directly - or as featured in claim 7 by means of UV-light - trigger a visualisation.

According to an embodiment as featured in claim 8, an aqueous solution of the fluorescent colorant uranine (the sodium salt of fluoresceine) is used that distinguishes itself in having a very intense colouring and powerful fluorescence that makes it easy to visualise with UV-light in very small amounts (a dilution of uranine in a ratio of 1 to 200 mill in pure water can readily be detected by the human eye), and in being approved for use as trace substance for, among other things, life saving at sea, tracing of subterranean water current and checking of weak blood circulation in humans. Thus there will not be any problems associated with obtaining permissions to use this substance in the foodstuffs industry, and it does not present an environmental hazard.

As stipulated previously, it will be associated with considerable advantages to use the methods for leakage control and localisation of leakages, respectively, in accordance with a combination of claims 1 and 2; and these advantages are obtained by - as stipulated in claim 9 - a leakage control being performed in a first step in which a colorant-containing solution is supplied to one of the product and service sides, whereas a clear liquid that is recycled is applied to the opposite side, whereby the presence of leakages in the heat exchanger is verified by detection of the colorant in the clear liquid; and in a second step being performed in which the presence of leakages is revealed by pressurisation of the

side containing the colorant-containing solution for a period of time while the other side is allowed to continue to contain air, following which the heat exchanger is drained and disassembled, and the localisation of the leakages is determined by visual inspection of the plates.

Hereby leakages are detected in an exact manner and localised with a single test liquid as a direct consequence of the colorant being transmitted via the leakages in the surfaces between the product and service sides, and the thus proportional amount transmitted to the surface.

It is enabled by the method to carry out the leakage control and the localisation of leakages under conditions that correspond to the actual operating conditions of the heat exchanger.

This renders the method according to claim 9 equally suitable for control of leakages in all types of heat exchangers in true operating conditions independently of the specific construction, field of use and operating specifications of the individual heat exchanger (pressure, temperature, viscosity of liquids, etc.).

Now follows an explanation of an exemplary procedure for the method when used in a plate heat exchanger:

1. The secondary side of the heat exchanger is filled with an aqueous colour-solution and this side is pressurised at eg 6 bar.

2. The primary side of the heat exchanger is recycled with pure water via pump and balance tank.

3. After approximately 15 minutes a water sample is extracted from the balance tank, the colour of said sample being visually, and optionally by means of UV-light, compared to a sample of pure water.

4. In case the water sample from the balance tank is devoid of colour and like the pure water sample, the heat exchanger does not leak, and the procedure is discontinued. If the water sample from the balance tank is coloured compared to the pure water test, the heat exchanger leaks, and the procedure continues.

5. The primary side of the heat exchanger is drained and is allowed to stand for eg 15 more minutes while pressurised.

6. The heat exchanger is opened and the plate surfaces of the primary side are inspected visually and optionally by means of UV-light to detect discoloration of the surface.

7. Discoloured plate surfaces have leakages and are replaced, following which the heat exchanger is assembled and is again ready for operation.

As will appear the leakage control and localisation of leakages is performed by use of the same colorant solution, and it will be possible to regulate the conditions in which the leakage control as well as the localisation of leakages are performed, in order to hereby ensure that they correspond essentially to the actual operating conditions of the heat exchanger.

C l a i m s

1. A method for leakage control of the internal faces that separate the primary and secondary sides of a plate heat exchanger, **characterised in** that a leakage control is performed in a first step wherein a colorant-containing liquid is supplied to one of the primary and secondary sides, while a clear liquid that is recycled is supplied to the opposite side, whereby the presence of leakages in the heat exchanger is verified by detection of the presence of the colorant in the clear liquid.

2. A method for localization of leakages between the product and service sides of a heat exchanger by use of a colorant that passes through the leakages and is subsequently detected visually, **characterised in** that a colorant-containing liquid is supplied to the one side of the heat exchanger, and that this side is pressurised for a period of time, while the opposite side is allowed to continue to contain air, following which the heat exchanger is drained and disassembled, and the location of the leakages is determined by visual inspection of the plates.

3. A method according to claim 1 or 2, **characterised in** that the differential pressure between the product and service sides is close to or identical with the differential pressures prevailing during actual operation of the heat exchanger.

4. A method according to claim 1 or 2, **characterised in** that the viscosity of the colorant-containing liquid corresponds to the viscosity of the liquid that passes

through the corresponding side of the heat exchanger in actual operation.

5. A method according to claim 1 or 2, **characterised in** that the passage of the colorant-containing liquid corresponds to the passage on the corresponding side of the heat exchanger in actual operation.

6. A method according to claim 1 or 2, **characterised in** that the colorant is a fluorescent substance.

7. A method according to claim 1 or 2, **characterised in that** the detection of the colorant is effected by use of UV-light.

8. A method according to claim 1 or 2, **characterised in** that the colorant is a salt of fluoresceine, preferably the sodium salt uranine thereof.

9. A method for in situ leakage control and localisation of leakages in the internal faces that separate the product and service sides of a heat exchanger, **characterised in** that a leakage control is performed in a first step wherein a colorant-containing solution is supplied to one of the product and service sides, while a clear liquid that is recycled is supplied to the opposite side, whereby the presence of leakages in the heat exchanger is verified by detection of the colorant in the clear liquid; and that, in a second step, the presence of leakages entails that the side with the colorant-containing solution is pressurised for a period of time, while the other side is allowed to remain filled with air, following which the heat exchanger is drained and

disassembled, and the location of the leakages is determined by visual inspection of the plates.

Substitute Sheet (Rule 26)

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

This declaration is of the following type:

☐ original . ☐ design ☐ supplemental
☒ national stage of PCT
☐ divisional ☐ continuation ☐ continuation-in-part

My residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first, and sole inventor *(if only one name is listed below)* or an original, first, and joint inventor *(if plural names are listed below)* of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A METHOD FOR LEAKAGE CONTROL AND LOCALISATION OF LEAKAGES IN THE INTERNAL FACES OF HEAT EXCHANGERS

the specification of which:

☐ is attached hereto.
☐ was filed on as Application No. and was amended on *(if applicable)*.
☒ was filed by Express Mail No. EL643546157US *as Application No. not known yet,* and was amended on September 21, 2001 *(if applicable)*.
☐ was filed on as PCT International Application No. PCT/ and was amended on *(if any)*.

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information that is material to the patentability of the application identified above in accordance with 37 CFR 1.56.

I claim foreign priority benefits under 35 USC 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent, utility model, design registration, or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter and having a filing date before that of the application(s) from which the benefit of priority is claimed.

PRIOR FOREIGN PATENT, UTILITY MODEL, AND DESIGN REGISTRATION APPLICATIONS						
COUNTRY	PRIOR FOREIGN APPLICATION NO.	DATE OF FILING (day,month,year)	PRIORITY CLAIMED			
Denmark	PA 1999 00392	22 March 1999	X	YES		NO
				YES		NO
				YES		NO

I claim the benefit pursuant to 35 USC 119(e) of the following United States provisional patent application(s):

PRIOR U.S. PROVISIONAL PATENT APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC 119(e)	
APPLICATION NO.	DATE OF FILING (day,month,year)

I claim the benefit pursuant to 35 USC 120 of any United States patent application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this patent application is not disclosed in the prior patent application(s) in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose material information as defined in 37 CFR 1.56 effective between the filing date of the prior patent application(s) and the national or PCT international filing date of this patent application.

PRIOR U.S. PATENT APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S., BENEFIT CLAIMED UNDER 35 USC 120					
U.S. PATENT APPLICATIONS			Status *(check one)*		
U.S. APPLICATION NO.	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
1.					
2.					
3.					
PCT APPLICATIONS DESIGNATING THE U.S.			Status *(check one)*		
PCT APPLICATION NO.	PCT FILING DATE (day,month,year)	U.S. APPLICATION NOS. ASSIGNED (if any)	PATENTED	PENDING	ABANDONED
4. PCT/DK00/00132	21 March 2000			X	
5.					
6.					

DETAILS OF FOREIGN APPLICATIONS FROM WHICH PRIORITY CLAIMED UNDER 35 USC 119 FOR ABOVE LISTED U.S./PCT APPLICATIONS				
ABOVE APPLICATION. NO.	COUNTRY	APPLICATION NO.	DATE OF FILING (day,month,year)	DATE OF ISSUE (day,month,year)
1.				
2.				
3.				
4. PCT/DK00/00132	Denmark	PA 1999 00392	22 March 1999	
5.				
6.				

In re Appln. of Per Bruun FAMME
Attorney Docket No. 213503

As a named inventor, I hereby appoint Leydig, Voit & Mayer, Ltd. to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Customer Number 23460.

I further direct that correspondence concerning this application be directed to Leydig, Voit & Mayer, Ltd.: Customer Number 23460.

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of **sole or first inventor:** Per Bruun FAMME

Inventor's signature _____

Date 15.10.01

Country of Citizenship: Denmark ✓

Residence: Odense C, Denmark DKX
(city/state or country)

Post Office Address: Hunderupvej 28, DK-5000 Odense C, Denmark
(complete mailing address)